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A CLINICAL STUDY
OF THE
ETIOLOGY AND TREATMENT
OF
SUMMER DIARRHŒA OF INFANTS.

BY



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**A CLINICAL STUDY OF THE ETIOLOGY AND
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THE season when this fearful scourge enters upon its annual mission of destroying health and life is upon us, and it is meet that we discuss again, though it be for the thousandth time, this all-important subject.

There was a time when I actually dreaded the approach of summer. So fatal was this disease, that it was my wont in the beginning of the season to pass mentally in review the innocents who in the community in which I then resided were ready for the slaughter by reason of their ages and the method of feeding applied to them.

I had been taught to regard this disease as an inflammation of the gastro-intestinal tract, chiefly as an entero-colitis, which required minute doses of mercury, with opium and poultices, and astringents in the later stages.

The results of this treatment may be gathered from the following extract from my record book, written August 21, 1869:



“Four cases of this disease have proved fatal in my hands this summer, despite of all efforts; besides one I saw in consultation, and several other fatal cases were communicated to me by colleagues. When I reflect upon the inefficiency of treatment in these cases, and by what strenuous efforts and most anxious care those which survived were saved, I am bound to feel that there must be something erroneous in my conception of the pathology of the disease.”

As long as I regarded summer diarrhoea as a purely inflammatory disease, the treatment continued unsatisfactory; the mild cases recovered and the more severe succumbed. The prognosis has, however, become more favorable since the faulty character of this theory became apparent, and since the adoption of less active medicinal treatment and more careful attention to the removal of irritating matters; together with a due regard to food and other hygienic essentials.

It is my belief now, that the summer diarrhoea of infants is chiefly, though not solely, due to the indigestion and multiplication of microorganisms which create in the gastro-intestinal tract conditions somewhat similar to those found in wounds to which septic material has had access. As in the latter, we observe heat, redness and swelling, signifying inflammation, with all its concomitants and sequelæ, modified by the position and functions of the parts involved; so have we in the former, inflammations whose disturbing influence is exerted upon the organs

involved, and which give rise to the manifestations of so-called entero-colitis.

Certain it is that the theories hitherto prevailing with regard to the etiology of this disease are faulty. They have served to lead us into faulty methods of treatment. Both these propositions I shall aim to demonstrate.

The causes of summer diarrhœa are usually enumerated as follows :

1. Insanitary conditions, such as overcrowding, poverty and filth.
2. Artificial feeding.
3. High atmospheric temperature.

In the light of recent studies on this subject, we cannot accept these causes as playing more than the *rôle* of predisposing elements favoring the development of bacteria, which are the true potential causes of summer diarrhœa.

1st. That insanitary conditions, poverty, overcrowding and filth are entitled only to the claim of predisposing elements, is made evident by the fact that summer diarrhœa is not a disease confined to crowded cities, nor to those localities in cities where large masses of population are huddled together, nor is it limited to the poorer classes, the lower strata of society. Not unlike traumatic fever, it prevails in all localities, wherever the elements favoring its development are in operation. I am aware that this view is not generally accepted, but my personal experience sustains it, for I have observed the ravages of the disease in the dwellings of a rural town, in the isolated log cabins of the plantation

negro, where the pure breezes pass freely through large crevices; I have seen it as fatal in the piney woods of South Carolina as in the better dwellings of this great city. Indeed, I may say that my observations on summer diarrhœas have been almost entirely made in the localities and among the people referred to. Although I have treated a few cases in the tenement-house districts of this city, my principal experience has been gathered at Washington Heights, the section which lies north of One Hundred and Forty-fifth Street, between the Hudson and Harlem rivers. Several cases and one death were observed in that lovely suburban group of dwellings called Audubon Park. A more clean, airy and healthful spot cannot be found in this city, and yet, right here, I have encountered cases as severe as in the dwellings of the Germans and Irish in the district beyond it, or in the negro cabins of the South. And, again, I have spent three summers at one of the most popular summer resorts, and here this grim spectre stalked abroad, defying the pure ozone wafted across a broad expanse of ocean.

These observations have demonstrated conclusively that while filth, overcrowding and poverty do increase and enhance the fatality of summer diarrhœa, they do so precisely for the same reasons which would operate in any other septic disease. Overcrowding, poverty, filth and insanitary conditions enhance the fertility of the soil and favor the multiplication of microorganisms which are introduced with the food into the gastro-intestinal tract.

2d. Artificial feeding. That this is a predomi-

nating factor in the production of summer diarrhœa has long been accepted by the profession. The fact that the disease is comparatively rare among breast-fed infants established artificial feeding as a prominent predisposing cause. Meinert, of Dresden (*Jahrbuch der K. Krankheiten*, 1884), shows in his careful statistics that, out of 500 cases of summer diarrhœa, only 4 per cent. were among breast-fed children. Hope informs us that, among 1000 deaths from summer diarrhœa of infants, only 30 were among purely breast-fed infants.

It has long been sought to account for this immense difference by the difference in composition of the milk derived from the human mamma and that obtained from the cow, which is the most universal substitute for the former. But heterodox as it may seem, I am inclined to the belief, which has almost crystallized into a conviction, that this is an error which has been a veritable *ignis fatuus* in the study of this subject. The chemical composition of cow's milk has been investigated again and again, and authors have presented us with tables, each varying from the other, showing the various elements of difference existing between it and human milk. One writer has handed down to the next the same suggestions, viz., so to change by various methods of preparation, dilution, saccharification and even predigestion of the artificial food, as to approximate it most nearly to the natural food. Has the result been adequate to the labor bestowed upon the subject? Are we more successful to-day in preventing summer diarrhœa than formerly? I doubt it. We

still find to-day a serious and fatal form of diarrhoea prevailing during the summer months, which we do not encounter during the spring and winter months. *And yet the system of feeding is precisely the same at all seasons.* Infants take cow's milk with impunity throughout the winter months and thrive admirably; indeed, some of the most robust infants have been thus nourished. But when the blighting temperature of summer comes, the scene changes at once, diarrhoea ensues, the baby languishes, and, perhaps after some exceptionally hot day, we are summoned in haste to see it, beyond hope of recovery, or in the inception of an attack which may terminate in a chronic entero-colitis that will sap the constitution and change the robust infant into a mere shadow of its former self. Have we not all passed through this experience? The tolerance of the infant stomach during the winter months is remarkable, and yet this fact has not received the attention it deserves. No complaint is made of the food, unless an attack of indigestion, probably due to overfeeding, occurs, which soon subsides if the food is changed or withheld. No anxiety occurs if such an attack ensues *during the winter months*, but let even the premonitory symptoms of diarrhoea show themselves during the summer months in an artificially fed infant, how different is the experienced physician's prognosis! At once he sees danger ahead, and preparations are made for battling with an enemy, who has so often defeated him that he has learned to dread his first appearance. Why this difference? It cannot, it does not, rest upon the difference in the chemical

constituents of cow's milk. Indeed, the valuable researches of Escherich (*Jahrbuch für Kinder Kr.*, Oct. 1887) have shown, what we all have learned by observation (during the winter), that the great hue and cry about the inappropriateness of casein from cow's milk to infantile nutrition has no foundation. Escherich has fed a healthy infant, ten weeks old, on pure cow's milk, one quart per diem, thus giving the stomach a far larger quantity of casein to dispose of than a nursling of the same age would obtain from the breast, with the result, that he found upon careful examination of the feces an almost ideal digestion of the casein. He was so astounded by the outcome of this experiment that he did not venture to publish it, until he learned that Uffelmann and Forster had reached the same conclusions. He thus was led to the emphatic declaration that "there is no doubt that healthy nurslings are capable of utilizing in the most complete manner cow casein in quantities far in excess of their requirements of nitrogen." Examinations of the feces have established this fact as positive in his mind. If albuminoid bodies approximating casein are found in excess in infants nourished with cow's milk, this is the result of habitual overfeeding, rather than an inability of the gastro-intestinal canal to appropriate the cow casein. "After these investigations," says Escherich, "let not another word be said of the digestion of cow's milk being more difficult in the normally developed infant than the digestion of breast milk."

While I would not be willing to go as far as

Escherich, I cannot escape the conclusion, that clinical observations, sustained by the chemical investigations here referred to, point to the fact that practically cow's milk is not so illy adapted to the nutrition of infants as has been generally accepted. Hence the reason of its being so potent a factor (either when taken alone or in connection with other so-called foods) in the production and maintenance of summer diarrhœa must be sought in another direction.

3d. High atmospheric temperature doubtless exercises an important influence in the production of summer diarrhœa. Indeed, the name would indicate that this factor is of paramount import. As I have said above, a diarrhœa occurring in a bottle-fed infant, in a temperature of 40° F., is regarded by us with equanimity, while the same disturbance in a temperature of 95° F. at once creates anxiety. In what manner does the elevation of temperature so completely change the prognosis? It has been generally held that the depressing effect of high temperatures upon the sensitive organization of infants, together "with the noxious exhalation from various sources with which the atmosphere is loaded, as a consequence of the heat" (J. L. Smith), explains this difference. But here, too, as in the matter of artificial feeding, we have probably been searching in the wrong direction. For, while there is no doubt that the depressing effect and the noxious exhalations due to high temperatures are *predisposing* elements, the fact stares us in the face, that nurslings who are as much exposed to these influences as bottle-fed children enjoy so

remarkable an immunity from the disease, as Hope, Meinert and others have mathematically demonstrated. True, it may be held that, being more healthfully nourished, they may be fortified against these noxious agencies arising from heat; but if this were the correct interpretation, the difference would not be so immense as 4 to 96 (Meinert) and 3 to 97 (Hope). We cannot, therefore, accept this explanation of the action of high temperature in the production of summer diarrhœa.

Clinical observation has demonstrated that the three factors referred to, viz., *insanitary surroundings, artificial feeding and excessive heat act in unison in the production of summer diarrhœa*. But, while this is true, their *modus operandi* has, up to the present time, been misunderstood. I am almost convinced that the *kind* of food, if it be reasonably constructed with due regard to the physiological functions of the infantile digestive tract, would be of minor importance *if we could prevent the access of microörganisms in its preparation*.

The reason why cow's milk prepared in the old-fashioned way, by dilution, warming and sweetening, does not produce serious diarrhœa in winter, while it almost invariably does so in summer, lies not so much in its large amount of casein and fat, and smaller amount of sugar, etc.; but more in the fact that *a high atmospheric temperature favors the development and multiplication of bacteria*.

It is a matter of common observation that milk turns sour more readily in warm weather than in cold. Soxhlet has shown this difference in mathematical

degrees, viz. ; that milk curdles 330 times faster in a temperature of 95° F. than at 58° F. Here we have the whole matter in a nutshell.

It was first shown by Pasteur, as long ago as 1857, that the curdling of milk is due to a bacterium lactis ; and since that time Schröder, v. Dusch, Lister, Hueppe, Marpman, Löffler and others have labored effectively to clear up the subject of milk bacteria. It has been demonstrated that milk sugar is transformed into lactic acid by the bacterium lactis, with development of CO₂, and that not all milk fermentation is due to a single organism.

But the most important discovery in connection with this subject was made by Lister, who, in following up the original researches of Pasteur, ascertained that a drop of sour milk, introduced into urine or into any appropriate culture fluid, gave rise to a remarkable development of bacteria of various kinds and degrees of mobility, and that a drop containing any of the latter would again produce souring of milk.

It requires no great stretch of deduction to believe that, when the various bacteria rapidly developed in warm weather in cow's milk after it leaves the udder reach the stomach of an infant depressed by excessive heat and perhaps by insanitary surroundings, their number may be rapidly multiplied ; fermentation may thus be set up with evolution of gases, which in turn fructifies the soil for their increased development. The proper breaking up of casein is interfered with and it passes into the intestinal canal, carrying with it masses of bacteria, which, joining those present in the canal, become the parents of such large

colonies of various types, that the intestinal tract becomes inflamed and ptomaines are formed, thus giving rise to the local lesions and general phenomena of summer diarrhœa.

That this is not a theory unsupported by demonstration is shown by the investigations of Baginsky, Nothnagel, Booker, Escherich, Hayem, Lesage, Le Gendre and others. In his work (*Die Verdauungskrankheiten der Kinder*, published in 1884), Baginsky refers to his microscopic examinations of the intestinal walls in follicular diarrhœa and cholera infantum, with a view to ascertain if the pathological lesions are coincident with the appearance of microorganisms in the intestinal canal and if this connection is of etiological significance. After carefully eliminating, by processes which he describes, all "cadaveric microorganisms," he succeeded in separating four different varieties, which he describes clearly and which, he is sure, are not post-mortem developments. He says that some of these so closely resemble those found in the stools that the conviction cannot be avoided that they are the same. The abundance of these microorganisms in the feces of the initial catarrh and their reappearance in the intestinal walls in cholera infantum lead him to the view that *they are essential factors in the production of these diseases*.

Booker has studied twenty-three varieties of microorganisms in the different forms of summer diarrhœa in children. The authors mentioned above have entered fully into this subject; but the aim of this paper being purely clinical, I must be content with a simple reference to their work.

These preliminary remarks on the probable causes of summer diarrhœa are necessarily brief, being intended simply as a prelude to the description of treatment. It would follow, from what has been said, that by the light of modern investigation we may recognize the erroneousness of our former management of these cases, and also the reason why such remedies as evacuants, mercurials, bismuth, creasote, etc., have afforded good results in many cases, while the opium treatment, which aimed to cure by quieting the peristaltic action, failed to accomplish any permanent result.

The treatment may be divided into prophylactic, curative and symptomatic. In the prophylaxis of summer diarrhœa the selection and preparation of the food stand first and foremost.

How can we select an infant food that will fulfil the chief indications of preventing the access of bacteria to the stomach?

We know that human milk is aseptic, hence it rarely produces fermentation and consequent diarrhœa, and I believe *this is its chief claim* to being the foremost food in the prophylaxis of summer diarrhœa. We know, also, that the best substitute for human milk is some preparation of cow's milk, and this is also aseptic when it leaves the udder. Human milk reaches the infant's stomach directly without admixture, while cow's milk reaches it after exposure to various contaminating influences. In the first place the act of milking alone must favor the production of bacteria. I speak from personal observations (having owned a herd of Alderneys) when

I say that it is utterly impossible, by the means hitherto in vogue, to avoid contamination. The stable may be ever so neat, the hands of the milker scrupulously clean, the teats carefully washed; but the act of milking involves a kind of churning of the milk deposited in the bucket by the stream propelled into it from the teats. This churning produces a large quantity of foam whose chief constituent is air containing the impurities which the most punctilious attention to cleanliness fails to eliminate from the stable or cow-yard. Besides these, solid particles, hair, etc., mix with the milk, which, though they may be removed by the customary straining, have lain long enough in the milk to contaminate it.

We who realize the necessity of constantly irrigating a wound during a surgical operation, in order to prevent its becoming septic from the air of even the most cleanly operating-room, must appreciate how utterly futile all efforts are to maintain the aseptic character of cow's milk as it flows from the udder. If we cannot fully accomplish such an aim, however, it is proper that an effort be made to diminish the chance for contamination by insisting upon scrupulous cleanliness of the stable, the cow, the milker and the milk receptacle. A bucket has recently been invented which is provided with a rubber cover and thus prevents to a great extent the gross contamination of the milk. The milking-tube would be very useful also, because by it the milk could be made to flow directly into a bottle; but this mode of milking is adapted only to cases in which a small supply is required by persons who own a cow.

The feeding and management of the cow are important, but can only be referred to here without entering into details.

The method recommended in 1819 by a German physician, Dr. Twierlein, of utilizing the goat as a wet-nurse, possesses considerable merit. It may be a troublesome method and, æsthetically, an absurd one. But in view of the fact brought out by the bacteriological researches referred to, the practice deserves a fair trial. Goats may be selected that have been rendered docile by training and practice when quite young and thus become useful for directly nursing the infant. Some inventive mind may devise a long nursing-tube with exhausting cup and nipple-shield, which may enable the infant to lie upon the mother's lap and draw its nourishment without being placed in contact with the animal. In view of the immense importance of this subject, our foundling asylums might very properly undertake experiments in this direction. It is certain that far more valuable results may be expected from experiments in this direction than from any therapeutic research or chemical investigation of other artificial foods.

Next in order, to prevent the access of contaminating matter, comes the destruction of such germs as may have been produced already, and which, if left alone, would surely go on and multiply until their presence is demonstrated by souring. Sterilization of cow's milk must and will be a most valuable preventive of summer diarrhoea. Unfortunately, however, the directions hitherto published for the process are either too complicated or too indefinite

to be of practical utility in the household. Soxhlet's apparatus nearly fulfils the indication, but it is cumbersome and expensive. Rotch, Jefferies and Caillé have given directions for steaming or boiling the milk from fifteen to twenty minutes, and they have succeeded in producing a milk which does not turn sour for a long time. The fact that such milk failed to turn sour is accepted by these able and conscientious writers as evidence that the milk is sterilized. But this is an error as Pasteur, Hueppe, Löffler, Lister and others have clearly demonstrated. Pasteur has shown that after boiling milk fifteen or twenty minutes the bacteria are indeed killed, but there is a development of infusoria *which do not render milk sour*, but which may nevertheless separate the casein *under an alkaline reaction*. Löffler found that, after boiling milk ten to twenty minutes and allowing it to stand, he was able to cultivate at least four different kinds of bacilli capable of producing spores, growing in milk and precipitating casein, *under alkaline reaction* (*Berl. klin. Wochenschrift*, 1887, p. 630). Schröder and von Dusch have demonstrated, and Pasteur has confirmed their conclusion, *that boiling is insufficient for the destruction of bacteria and spores, but that a continuous exposure for half an hour of the milk to a temperature of 130° C. (266° F.) is required to sterilize milk completely*.

Here, then, we have a standard for practical purposes. This may explain, by the way, why Caillé, in his valuable experiments (*Dietetic Gazette*, April, 1888), did not obtain quite as good results from his method as from boiling milk in Soxhlet's apparatus

for thirty minutes. The latter, boiled under pressure, remained good eighteen days, while the milk he boiled fifteen minutes only in open bottles was sour after five days, because it never reached a temperature above 212° F. As the absence of acidity, by taste or smell or litmus test, does not prove the complete sterilization of milk, it cannot be asserted that the milk in these experiments was so sterilized.

Fortunately the boiling of cow's milk is a great advantage, inasmuch as "boiled milk produces a much finer coagulum and is to be preferred otherwise; while concerning the length of its stay in the stomach, its behavior in the intestine, and the abnormal fermentation processes, there are no definite observations, we may regard it in these respects as the same as mother's milk" (Escherich, *Journal für Kinderk.*, October, 1887). This is not a recent discovery, however, inasmuch as A. Jacobi advised boiling of milk in 1875 already, and J. Albu ("Milchnahrung und Milchcuren," 1881) recommends Bertling's apparatus for boiling milk under pressure for twenty minutes. He states that coagulation germs are destroyed, as are also those of tuberculosis, typhus, scarlatina and diphtheria. He also states that cow-casein is made more soluble and digestible. His experiments and results have been repeated by Salkowski, who at the instance of Virchow made investigations of Boesken's process of boiling milk under pressure. Soltmann (*Berl. klin. Woch.*, May 29, 1882) says that boiling milk in Bertling's apparatus destroys germs and renders the casein finely flocculent. Reichman (*Archiv für*

klin. Med., Bd. 14, No. 6) experimented on nine adults in the digestion of milk, and found that while 10 ounces of raw milk left the healthy stomach four hours after being imbibed, boiled milk was digested in two and a half hours, and that the casein lumps were much finer in the latter. Smaller quantities, as 3 ounces of boiled milk, were digested in forty-five minutes. I have recently had occasion to ascertain how rapidly boiled milk, taken hot, is digested. I had the stomach of a dyspeptic washed out two hours after taking twelve ounces of hot milk, and found no curds, although mucus was abundant. Hence, boiling milk for infants will not only facilitate digestion, by softening the casein, but, if the boiling can be done under strong pressure, so as to raise the temperature to 266° F., it will also completely sterilize the milk. As the latter cannot be accomplished in a simple apparatus, we may approximate it by boiling the milk, in imitation of Soxhlet's plan, in tightly stoppered, strong glass bottles. A lower temperature, 230° F., will suffice, if it is continued for two hours (Schröder, von Dusch).

When the facts here referred to receive general recognition in the profession, dairymen will doubtless find it to their interest to obtain proper apparatus for sterilizing large quantities of milk, and delivering it in appropriate, sealed vessels to consumers for the use of infants in large cities.

Next in importance to the proper selection of the food comes the hygienic management of the infant. It is a well-known fact that impure air, overcrowding and want of cleanliness conspire to render the

morbidity and mortality from the disease greater in cities than in the rural districts. The same rule holds good here which, as mentioned above, applies to all diseases connected with microörganisms, whose multiplication is furthered by unsanitary conditions. The infant should receive a daily bath of tepid water, and I regard a rapid sponging subsequently with a sponge wrung out of cold water, followed by rapid drying and friction, as a most valuable aid in preserving the tone and resisting powers of infants over six months old. The baby should be almost constantly in the open air ; it should be kept cool, however, and never exposed to the direct rays of the sun in midsummer. A proper amount of undisturbed sleep should be provided, and all disturbances of the nervous system by excessive playing and fondling must be avoided. The infant should vegetate ; its days should pass away calmly and in the utmost comfort. Only by thus shielding it against untoward conditions may the helpless, artificially reared human young be safely tided over the dangers which the advent of summer strews in its path. Even the poorest mother may execute these simple suggestions with regard to the hygienic management of the infant.

A word may here be said of teething as a predisposing cause of summer diarrhoea, because necessity of proper management of the so-called dangerous period is so often urged upon mothers. Chapters have been written on this subject by the older authors, but the gum lance has happily been relegated to the drawer containing useless instruments. May it ever remain there !

Teething requires no special hygienic management, certainly not the aid of the gum lancet. While it may be true that during the evolution of the teeth, the nervous system and probably the digestive organs are in a more or less erethic condition, the fact must not be lost sight of, that this is a natural process which in the large majority of cases proceeds without any effect upon the system, provided there be no other disturbing element in operation. We do not encounter diarrhœa from teething in midwinter, nor later in life when the digestive organs are no longer in a susceptible condition.

The second summer is usually dreaded. The reason is obvious; even a breast-fed infant will then be weaned, and be subjected to the influences of food whose preparation or selection may be improper. The indiscriminate use of articles of food obtained from the table of its elders must be prevented, and ordinary hygienic rules, referred to above, must be enforced in order that diarrhœa be prevented during the teething period.

In connection with prophylaxis of summer diarrhœa, attention to the infant's mouth is important. Escherich in speaking of the normal digestion of the infant says:

“In the mouth the germ-free human milk undergoes no change, except its admixture with saliva and with the *bacteria residing in the oral cavity, which surely cannot be without significance in the development of many mycotic intestinal troubles.*”

It is advisable, therefore, during the summer months to cleanse the mouth with a weak solution

of boric acid or salicylate of sodium before the baby nurses. Sudden changes of temperature, which are liable to occur at night in August in this climate, and to which cases of diarrhœa may often be traced, are best guarded against by a flannel bandage around the abdomen and the constant use of socks.

Having considered the prophylaxis of summer diarrhœa in the light of the modern theory of its etiology, we may now proceed to the consideration of its curative treatment.

While it may be interesting scientifically to divide the summer diarrhœa of infants as Lesage and others have done, into several types, it will be of little practical value, since the fact remains that true summer diarrhœa is chiefly due to the presence of bacteria of various kinds which set up in the gastrointestinal canal fermentation and consequent inflammatory action, resulting in lesions which are pretty uniform in character, and objective manifestations.

The indications of treatment are :

1st. To diminish or remove the source of bacterial supply.

2d. To neutralize the disturbance produced by the bacteria.

3d. To remove them from the intestinal tract.

4th. To meet the nervous prostration, inanition, exhaustion and other manifestations due to the diarrhœa.

1st. To accomplish the first object will only be required in an artificially fed infant. A wet-nurse should, if possible, be procured. This being im-

possible, it is necessary to look into the mode of preparing the food supply. Sterilization of the milk and scrupulous attention to its preparation for the bottle are of the utmost importance, because in the diseased condition of the gastro-intestinal canal, which now contains quantities of fermenting material, bacteria introduced by the food will multiply more rapidly, as Lister has shown by his experiment of the effect of a drop of milk containing the bacteria of fermentation on any culture fluids. Even if vomiting be not present, the withdrawal of milk, for a short period, will be of great value. Barley-water, rice-water and meat broths, which have been deprived of fats, and which have been thoroughly boiled for half an hour, and rapidly cooled just before using, offer an excellent substitute for milk. A solution of white of egg in water, which has been sterilized by long boiling and cooled, one egg to the pint, taken cold, and in small quantities, is also a valuable nutriment, as it may be absorbed without requiring digestion. This may be continued until the stools assume a more normal appearance and consistence, when the regular food, or some one of the predigested foods, containing dextrin may be gradually resorted to.

2d. *To neutralize the disturbance produced by the ingested and multiplying bacteria.* If we have nausea and vomiting, rest of the stomach stands first and foremost, far beyond all other remedies, unless it be the cleansing of the stomach by irrigation, as recommended by Epstein. I have had no experience with the latter, but it is doubtless of value, and I shall

resort to it this summer. The stomach cannot be at rest until all fermenting material be removed from it. This I have hitherto accomplished by the copious administration, by the spoon or nursing bottle, of warm water, to which a small quantity of salt has been added. It is difficult, however, to execute this treatment. Epstein's irrigation of the stomach, by means of a soft rubber stomach-tube of small dimensions, would certainly be a great improvement.

The enforcement of absolute abstention from food and drink, in the early stage of summer diarrhœa, cannot be too strongly impressed upon the mother. It will require all the *morale* she possesses to execute the physician's directions. She may be convinced by the argument that since everything the baby takes is rejected, it is futile to continue to feed it or give it even water. When practising at Washington Heights it was my custom to send the women who brought their pale and shrivelled infants to me, during my morning hour, with a history of purging and vomiting during the preceding night, to a certain broad-limbed tree standing upon a rocky elevation at 165th Street, and instructing them there to await my arrival. Having neither food nor drink with them, the complete rest of the stomach and bowels was enforced, and this together with the exposure to pure air, under the shade of the tree, usually so restored these little ones in a few hours, that I have found them asleep and free from vomiting when I drove up to the extemporaneous sanitarium.

It is not only difficult to convince the mother that baby will not starve to death, if food and drink are

withheld for six or eight hours, but I have known intelligent physicians to labor under the same delusion. I well remember meeting, in consultation, a bright young colleague in the case of the largest six months' infant I have ever seen. The baby, though reared on the breast, was suffering from vomiting and purging, chiefly the former. Vomiting had been uninterrupted for twenty-four hours, and had lately produced serious collapse manifestations, which alarmed the attendant. But despite the refusal of the infant to take the constantly proffered breast, the anxious attendant had milk drawn from it, and forced the child to take it from a spoon. Complete abstention from this course reëstablished the integrity of the stomach, and change of food to broth, and, afterward, diluted cow's milk, together with rectal irrigation, restored the child to health.

There are few cases of vomiting which will not yield to complete abstention from food and drink for a few hours, after the stomach has been thoroughly cleansed. Mustard sinapisms to the epigastrium, and anti-emetic medicines only serve to disturb the patient. If rest does not bring relief, I resort to the old-fashioned Dewees' mixture of

R.—Magnesiæ ʒ ss.
 Spts. ammon. arom. ʒ ss.
 Aquæ menth. pip. ʒ ij.—M.
 Sig.—Thirty drops every half hour.

This checks fermentation and appears to soothe the irritation effectually. When this mixture cannot be retained at all, a dose of calomel, one-half to two grains, will almost invariably be retained, if admin-

istered immediately after vomiting, laid on a teaspoonful of water, without stirring, or placed dry upon the tongue, and followed by a few drops of water. Calomel not only acts as a parasiticide, but fulfils the indication of removing irritating matters from the intestinal canal.

3d. *To remove the bacteria from the intestinal canal* is a leading indication. It is important that all fermenting material which offers a nidus for their development should be swept out. A full dose of castor oil, or when the stomach is irritable a dose of calomel, will remove the entire mass from the upper tract. It will not be necessary to repeat the purgative if it is followed by thorough irrigation of the large intestine with sterilized warm water. I believe that in this procedure we possess a most valuable remedial measure for summer diarrhœa. But it must be borne in mind that irrigation cannot be accomplished by an *enema* of warm water. This would act as an irritant and create additional disturbance. A rubber horse catheter, or a large Nélaton catheter, should be used for this purpose, because its walls are firm and yet elastic, and its length admits of its deep introduction. It should be attached to the pipe of a fountain syringe, containing one quart of water that has been boiled for half an hour, and in which half a drachm of bicarbonate of sodium has been dissolved. The infant is placed upon the abdomen in the lap of an attendant. The tube anointed with vaseline, and firmly held between the thumb and index finger of the right hand, is gently introduced into the anus. The pressure of the fingers is now

somewhat relaxed, in order that the water may flow, while the tube is being gently but firmly pushed into the intestinal canal. Whenever it meets an obstruction it should be withdrawn a little, and gently persuaded to pass upward. Sometimes it is more readily introduced when disconnected from the syringe. When the upper point has reached the transverse colon, or cannot be introduced further, it is held quietly until about a quart of water has passed. There will be no distention, because the pressure of the child's body upon the nurse's lap will aid in expelling the water as rapidly as it is introduced. I have occasionally added with advantage one-half grain bichloride of mercury to the quart of water, allowing always an extra pint of plain water to follow the medicated injection, to prevent poisoning.

Experience has convinced me that thorough irrigation of the large intestine, administered by the physician or by a competent nurse, under special instruction, every three, four or five hours, lessens the number and changes the character of the movements, and produces a most soothing effect upon the patient. I have frequently seen infants, who had been tossing in pain, purging and vomiting, drop into a gentle slumber, while the water was still flowing. Almost invariably a quiet slumber follows the irrigation, the purging ceases, or is much modified, and the whole aspect of the case is changed. The result of the irrigation is the removal of bacteria, mucus, undigested food and fermenting material. Cantani has in the treatment of cholera succeeded

in reaching the stomach by such irrigations. J. L. Smith has found the lesions in summer diarrhoea "in all but one of eighty cases in the colon, in thirty-nine, nearly or quite through its entire extent; in fourteen it was confined to the descending colon; the portion of colon most frequently inflamed is just above the sigmoid flexure."

"In the large intestine, the cæcum, sigmoid flexure, and upper part of rectum were the portions in which the most advanced lesions were met with. In the small intestine the changes were generally limited to the lower part of the ileum," says Holt in *THE MEDICAL NEWS* of June 9, 1888.

Hence we may safely assume that the irrigations reach most of the diseased surface, and thus we follow the indications of modern therapeutics, to treat local troubles by local measures, as far as possible. The inflamed parts are not only soothed by these warm irrigations, but the *materies morbi*, which maintain the disease, are removed and neutralized. An incidental advantage, too, is the stimulation of the hepatic function, which this imitation of Krull's injections produces.

While I have, in cases of dysentery, resorted to the addition of bichloride of mercury with advantage, I regard the addition of antiseptics to the irrigating fluid as unadvisable, inasmuch as the solutions cannot be made sufficiently concentrated to effect the destruction of germs and spores without endangering the integrity of the mucous membrane, or menacing the system by poisoning from absorption. Further investigations may develop a perfected medicinal irrigation. For instance, Cantani's method of tannin

irrigations in cholera may be here initiated. In chronic and subacute cases these may be valuable, by local astringent action.

The internal administration of antiseptics, especially salicylate of sodium and naphthalin, has found able advocates, but if we consider how large a quantity would be required to sterilize so extensive a surface, we can scarcely expect any decided results from this practice. My own experience is confined to small doses ($\frac{1}{84}$ grain) of bichloride of mercury, and large doses of bismuth, both of which have proven valuable, chiefly in subacute or chronic cases; the former when the stools were clayey and offensive, the latter when they were thin and choleraic.

I must say, however, that in recent years it has been my constant aim to eliminate medicinal treatment from the management of acute summer diarrhœa, as from other acute diseases. It is of paramount importance to maintain the integrity of the stomach, which must be more or less impaired by the administration of drugs. When the stomach is restored sufficiently to receive and retain anything, I regard the introduction of food as far more important. Medicines should be administered *per rectum*, if possible, or avoided altogether. Doubtless our predecessors of the Meigs, Dewees and West school have had good results from "antiphlogistic" doses of mercury, because its antiseptic and purgative properties removed the bacteria and irritating matter, but they found it necessary to guard it by the addition of opiates, to prevent harmful purgation, while

they "stimulated the liver." If we can disinfect, cleanse and soothe the intestinal tract, and at the same time "stimulate the liver" by irrigations, the necessity of medicinal remedies becomes less pronounced.

4th. *To meet the manifestations due to the diarrhœa, and probably to absorption of ptomaines* is a plain indication. Prostration of the vital powers is often rapid and pronounced, threatening a speedy, fatal issue in many cases, from the very inception of the disease. I confess that, until recent years, the true cause of this alarming condition escaped me. Since the recognition of high body temperature as a cause of the prostration, the prognosis of these cases has become far more favorable in my hands.

An elevated temperature range frequently marks the advent of the summer diarrhœa, especially the more alarming types. Indeed, if the rectal temperature were more systematically observed, it would be discovered that a large number of severe cases are ushered in with and maintain a temperature ranging from 102° to 106° . So deceptive are the cool skin (especially of the extremities) and the clammy sweat produced by relaxation consequent upon the nausea, vomiting and diarrhœa, that the high internal temperature is liable to escape observation.

Since I have, during the past eight years, made it an invariable rule to ascertain the exact rectal temperature, I have again and again been surprised by the presence of hyperpyrexia when I least expected it.

The most gratifying result of this practice has

been the comfort and improvement of the patient accomplished by the reduction of the high temperature.

I have not resorted to medicinal antipyretics with sufficient frequency to offer reliable deductions. But the graduated cold bath, reduced from 95° to 80° , and continued until the thermometer in the rectum registers a decided fall of temperature, has brought me results which I have obtained from no other remedy. The reduction of temperature, if it can be maintained for twenty-four hours, and the stimulus of reaction from the cold-bath will, in acute summer diarrhœa, completely change the entire aspect of many cases. Vomiting and diarrhœa often cease, the most alarming head symptoms, restlessness, jactitation, screaming and squinting, are almost invariably removed or modified; sleep follows, and convalescence may be established in a brief time, if the cold-bath is resorted to early. After the bath the child should be wrapped in a sheet wrung out of the bath water, reaching from the neck to the knees, while the warmth of the feet is maintained by hot-water bags.

This paper being clinical, I will not enter into a theoretical explanation of the action of cold water in these acute cases. The following case will illustrate the method of administration and its results:

P. S., infant, six months old, vigorous and healthy, living in one of our best houses on the banks of the Hudson, had been weaned one month. Since that time he had been suffering from occasional diarrhœa, which had been treated with more or less success by my friend, the late Dr. Frothingham, and

myself for a week. On July 30, 1881, vomiting and choleraic stools prompted the mother to summon me in haste. I found the little fellow a changed being; his features were pinched, skin cold and clammy, eyes sunken; he could retain nothing, the bowels ejected a thin, green fluid about every half hour, sometimes more frequently. Drs. A. Jacobi and J. Lewis Smith were summoned in consultation by my request. The former was absent; the latter reached the house about five hours after the messenger was despatched.

In the meantime the symptoms grew more and more threatening, the pulse began to fail, the child lay with upturned eyes, pinched features, rapid, shallow respiration and cold extremities—on the brink of dissolution. It occurred to me to take the rectal temperature, and, to my great surprise, I found it 106° F. A cold-bath was immediately ordered, although the proposition so shocked the mother that she wrung her hands in despair, lest the infant should succumb to the cold. A large bathtub was half filled with warm water until the temperature reached 90° . The infant, whose stony gaze indicated the approach of eclampsia or impending dissolution, was submerged in the water, except the head; the lower and upper extremities were held up and chafed. Cold water was turned on, and ice-water was added, while the water was permitted to flow from the tub. In ten minutes the temperature of the water was reduced to 80° . A smile now passed over the baby's face, his eyes lost the stare, and he revived. His rectal temperature began to fall, and in ten minutes reached 100° . He was now wrapped in a cloth wrung out of water at 80° , from neck to knees; hot-water bags were applied to the extremities, and he was carefully covered. He fell into a sweet slumber, from which he awoke when Dr.

Smith arrived, to find him rescued from immediate danger. A wet-nurse and careful attention restored the child in a few days.

Inanition caused by the diarrhœa must be met by a cautious selection of food. I have dwelt upon the fact that in health cow's milk, sterilized shortly after leaving the udder, offers an excellent substitute for human milk, and is a good prophylactic against summer diarrhœa, because, as Escherich and Uffelman have shown, the *healthy* infant is perfectly competent to dispose of large quantities of cow's casein. But, when the digestive organs are enfeebled by disease, cow's casein will not be readily taken up, and will act as an irritant to the bowels. As broths and solutions of albumen can be used only as temporary substitutes, one of the prepared foods, constructed from pure, sterilized, partly pre-digested milk, with a proper proportion of dextrin and sugar of milk, to approximate in food value to human milk, will be found of great value. Here we need a partially predigested food, whose unirritating elements may be quickly taken up by the digestive organs without leaving much residue.

I have reported several cases strikingly illustrating the value of the most recent of these foods two years ago, and I have, since that time, observed similar results in two cases, one of these an infant whose mother had been compelled to accept a position as wet-nurse, and which was being fed on condensed milk. This baby had twenty-five stools a day, and was shrivelling up, when I stopped all nourishment, gave brandy and water, and then put him on

the prepared food, which, in a few days, produced a complete change.

Care is requisite in warning mothers not to add milk to these prepared foods containing milk, which they will be tempted to do in order to concentrate the food. It is important to impress upon them the danger of overfeeding in disease as well as in health ; to this cause much infantile gastro-intestinal disturbance may be charged. There is no limit to the amount a bottle-fed child takes, except its own free will and capacity. The former is limited by the supply in breast-feeding, hence the latter is rarely overtaxed. But in bottle-feeding the supply is unlimited : hence the quantity should be carefully guarded, and should be made appropriate to the age and digestive powers of the recipient.

Alcoholic stimulants are valuable as aids to tide over the danger of collapse and debility from inanition. Good whiskey and brandy are probably the best. Opiates are the only medicinal remedies that possess absolute effects in checking peristaltic action. I now have little confidence in the various astringents, which I formerly used extensively. As they were usually combined with opiates, it was impossible to judge their intrinsic value. After all irritating matter has been removed from the gastro-intestinal tract, opiates are most valuable measures for allaying the irritation of the intestinal canal and comforting the patient, but their administration has hitherto been too indiscriminate.



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